

Drawing inspiration from the creativity of Picasso, the functional esthetic of da Vinci, and the precision of Michaelangelo, chemists working in the nanotechnology field could be considered artists-sculptors working with nanometer resolution. Beyond their aesthetic appeal, created nanomaterials exhibit unique properties contributing to the progress of science and technology.

It's crucial to note that the simplest nanocrystals began to be efficiently obtained three decades ago. At that time, they were a groundbreaking element in discussions of the world's quantum nature. Today, these nanocrystals power cutting-edge TVs and bio-diagnostic tools. Over the past 30 years, the art of nanocrystal synthesis has rapidly evolved, allowing the creation of nanoparticles in myriad shapes and contributing to scientific discoveries at the intersection of chemistry, physics, and medicine. However, despite significant progress in synthesizing nanocrystals with various geometries, one intriguing challenge remains unresolved, which resists the effort and experiences of hundreds of scientists. We are yet to obtain perovskite nanocrystals with twisted (chiral) morphology. Chiral, meaning that the nanocrystals with opposite twists will be mirror images of each other and will not be identical. Such nanomaterials are extremely important for developing many light-based technologies related to communication methods, data processing, and medical imaging.

Within the PER-ELITE project (Liquid crystalline thin films for the synthesis of morphologically chiral PERovskite nanocrystals with Enhanced dissymmetry of LIghT Emission), we propose a bold hypothesis that twisted perovskite nanocrystals can be achieved using soft, organic templates that will guide the growth of nanocrystals. Obtained materials will combine the excellent optoelectronic properties of perovskite nanocrystals (e.g., high quantum emission efficiency) with the benefits resulting from chirality (e.g., emission of circularly polarized light, ability to interact with electron spins). To achieve success, we will leverage our many years of experience and knowledge in synthesizing organic nanomaterials, obtaining chiral nanostructures, and combining organic and inorganic materials.

The project's key and most time-consuming part will be developing a method for fabricating chiral perovskite nanocrystals. Our strategy involves optimizing the structure of organic materials and fine-tuning synthetic conditions. We will perform a detailed characterization of the obtained nanomaterials, including chiroptical properties. This information will be used as feedback to further optimization of the synthetic method. We will also explore their potential as efficient sources of circularly polarized light and materials selecting electrons based on their spin. It is worth noting that these properties are essential for next-generation communication technologies, computing, data transmission, and body imaging during surgical interventions.

In summary, the PER-ELITE project explores the new dimensions of nanotechnology by achieving perovskite nanocrystals with chiral morphology. We will push the boundaries of nanomaterial synthesis not only for the aesthetic beauty of nanotechnological products but also as the crucial foundational step to fully harness the potential of chiral perovskite nanocrystals. By pioneering chiral nanocrystal synthesis, we will gain a crucial intellectual advantage, directly benefiting the progress in photonics, computation, and medicine research areas.